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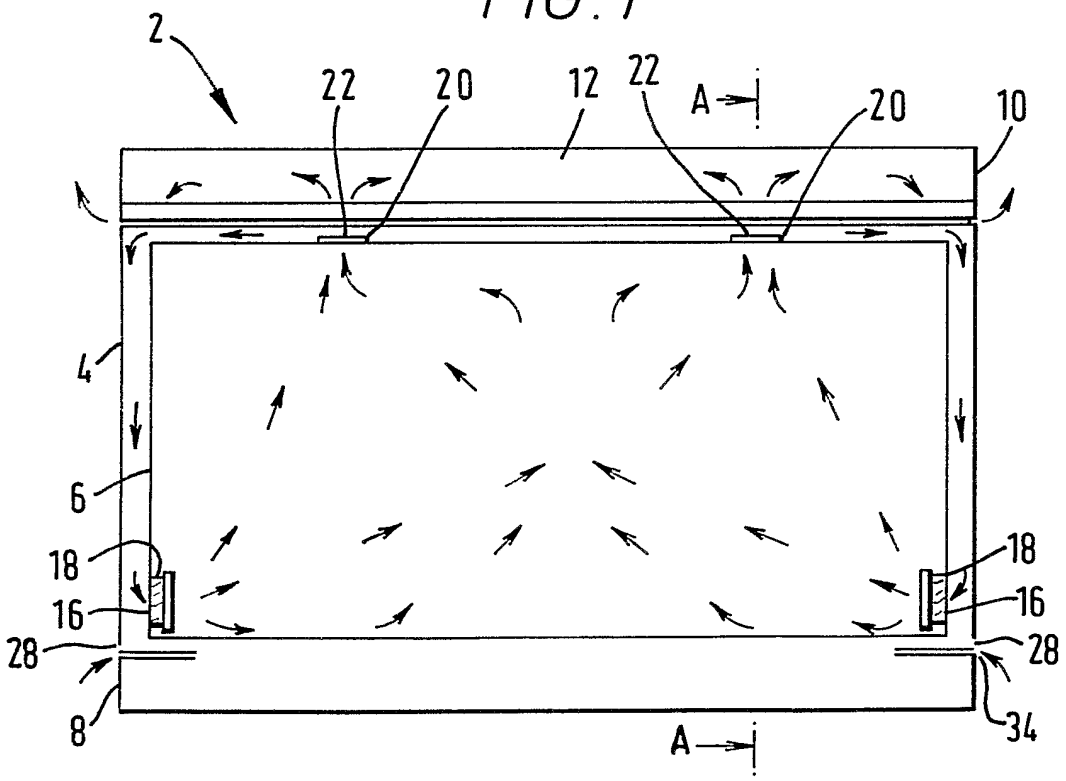
(56) Documents cited
GB 2202681 A **GB 1449895 A** **GB 1084658 A**
EP 0225954 A1 **EP 0112994 A2** **WO 81/01045 A1**
US 4495545 A

(58) Field of search
UK CL (Edition K) **A4B, B8P, F4V VGAB VGAC, H1R RBK RBL RBM**
INT CL[5] **H05K**

(54) **Electrical apparatus enclosure**

(57) An electrical apparatus enclosure 2 is provided with an outer casing 4 and an inner casing 6 for housing electrical equipment. Air is recirculated from the interior of the inner casing 6 through an air gap between the inner casing 6 and the outer casing 4 and back to the interior of the inner casing 6. The recirculation of air reduces the temperature difference between the walls of the inner casing 6 and the air within the inner casing 6. Condensation that forms on the inner face of the outer casing 4 leaves through drain holes 28 at the base of the inner casing 4. A roof chamber 12 is separated from the inner casing 6 by a baffle. Some of the air leaving the inner casing 6 through outlet openings 20 passes into the roof chamber 12 and is exhausted through exhaust openings 32 so as to remove heat from the enclosure. The air may be forced to recirculate by driven fans 16 which are provided with air filters. The pressure of the air within the inner casing 6 is maintained above that of the air in the air gap between the inner casing 6 and the outer casing 4.

FIG. 1



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 262 190 A

FIG. 2

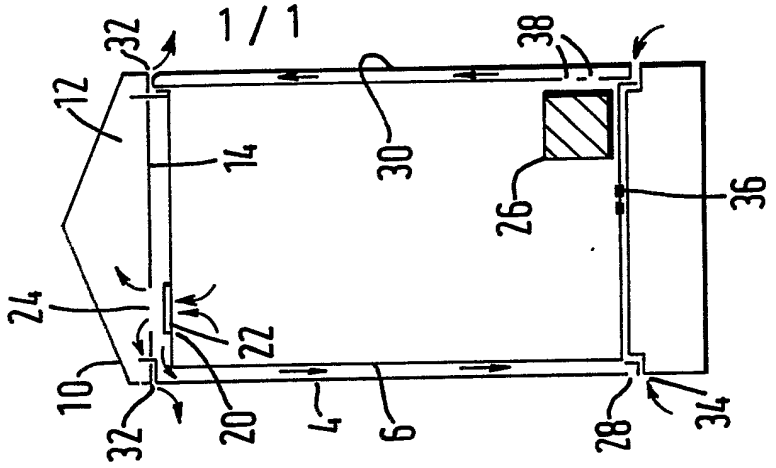

32
12
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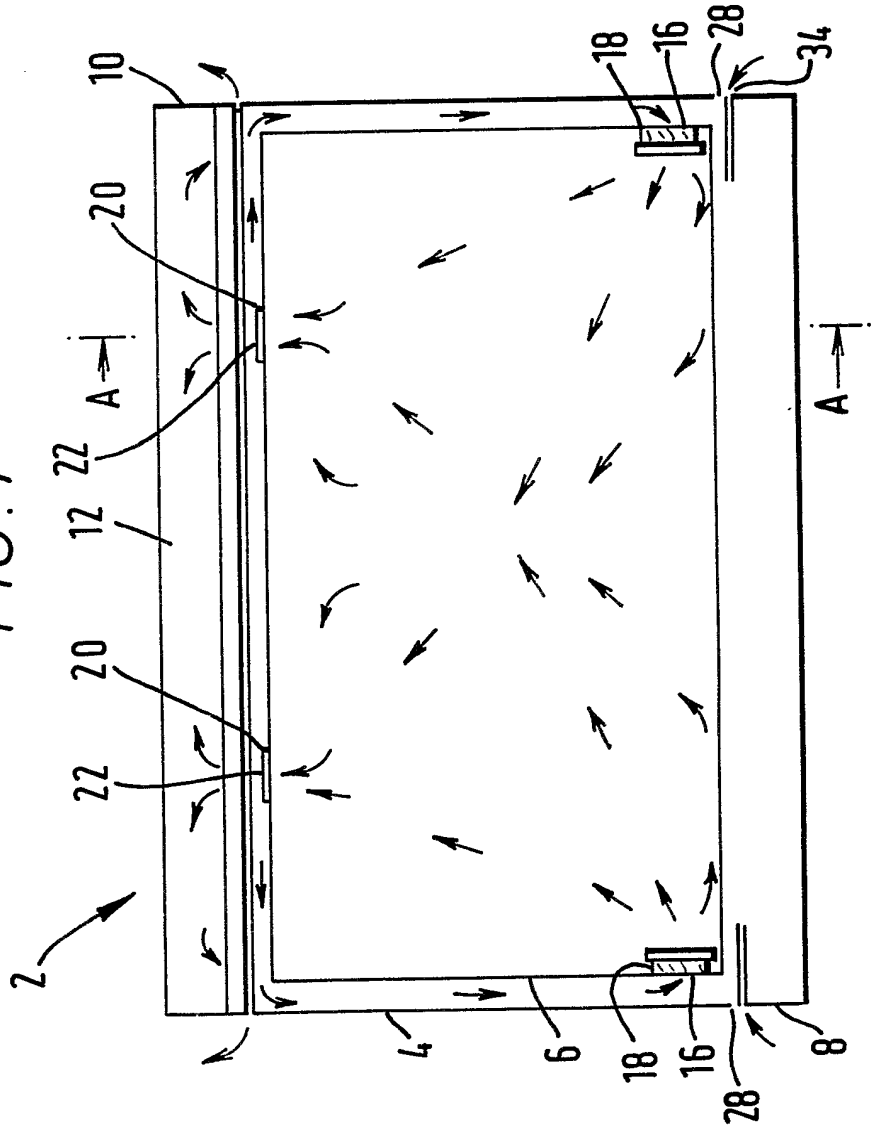
FIG. 1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ELECTRICAL APPARATUS ENCLOSURE

This invention relates to electrical apparatus enclosures. More particularly, this invention relates to electrical apparatus enclosures of the type used to house electrical apparatus in harsh environments.

It is known to provide electrical apparatus enclosures for installation in harsh outdoor locations. The electrical apparatus housed within the enclosures can be of many forms, e.g. telephone cross connection apparatus, cable television apparatus or traffic signal control apparatus. Such electrical apparatus enclosures must be mechanically strong to resist both accidental and deliberate damage. Accordingly, it has been found appropriate to use a metal construction for the enclosures.

In addition to being mechanically strong, the enclosures must also protect their potentially delicate and expensive contents from climatic extremes. A particular problem that can arise is the formation of condensation within the enclosures. Such condensation can have a very damaging effect upon the electrical apparatus housed within the enclosure. This problem is particularly severe when the electrical apparatus within the enclosure is of a type which does not generate any heat during its normal operation and so is not capable of drying itself. An example of such electrical apparatus is telephone cross connection apparatus.

Telephone cross connection apparatus consists of many hundreds, or perhaps thousands, of simple wire to wire connections between subscriber and exchange telephone lines. Telephone cross connection apparatus generates substantially no self drying heat and yet can suffer severe problems due to moisture induced corrosion of the contacts.

One previous attempt to overcome this problem has been to hang bags of desiccator within the enclosures to absorb any condensation. The bags of desiccator require disadvantageously frequent changing to remain effective.

Another approach has been to encapsulate the wire to wire connections themselves to protect them from attack by moisture. An example of this approach is the MS^2 cross connect system produced by 3M (MS^2 and 3M are trademarks of Minnesota Mining and Minerals

Corporation). This approach is treating the symptom rather than the cause and does not remove the condensation from the enclosure.

According to the present invention there is provided an electrical apparatus enclosure comprising

an outer casing,

an inner casing with an interior for housing electrical apparatus, said inner casing being disposed within said outer casing and having one or more inlet openings and one or more outlet openings, and

means for causing an at least partially recirculating air flow around a path including said interior of said inner casing and an air gap between said inner casing and said outer casing.

The combination of the inner and outer casings and the at least partially recirculating airflow serves to protect any electrical apparatus within the inner casing from condensation. Condensation occurs when warm moist air within the enclosures comes into contact with a cooler (typically metal) wall of the enclosure. An extreme example of this situation is an enclosure in an outdoor situation in a tropical environment. Features of such climates are very high levels of humidity and heat and sudden, heavy rainfall. Over time, warm and humid air makes its way inside the enclosure and then sudden, heavy rainfall rapidly cools the outer casing of the enclosure. The warm moist air inside the enclosure contacts the cool walls and condensation is formed.

This invention overcomes this problem by providing an inner casing within the outer casing and recirculating air between the interior of the inner casing and the air gap between the outer casing and the inner casing. The recirculation of air reduces the possibility of a temperature difference occurring between the inner casing and the air within the enclosure since both sides of the inner casing are in contact with the recirculating air. Any condensation that does occur will form on the inner face of the outer casing and will be physically separated by the inner casing from any sensitive electrical apparatus within the inner casing. This invention provides an arrangement which is relatively simple and inexpensive to produce and yet provides an effective, permanent solution to the problem of reducing condensation.

In order to ensure an effective recirculation of substantially

all the air within the inner casing, said one or more inlet openings are disposed on a far side of said inner casing relative to said one or more outlet openings. This arrangement helps prevent pockets of static air forming within the inner casing.

It will be appreciated that the means for causing an at least partially recirculating airflow could take many forms. In particular, if the electrical apparatus housed within the enclosure produced some heat, then convective airflow might be sufficient to drive the recirculation. However, in preferred embodiments of the invention said means for causing an at least partially recirculating air flow comprises one or more driven fans. In this way, a reliable recirculating airflow of sufficient magnitude can be established.

A preferred feature of embodiments of the invention is that said one or more driven fans include air filters. These air filters serve to protect the electrical apparatus that may be housed within the enclosure from impurities in the recirculating air.

A particularly preferred arrangement is one in which said one or more driven fans are disposed in said one or more inlet openings and act to increase air pressure within said inner casing above that within said air gap. The pressurising of the air within the inner casing relative to that within the air gap ensures that if any unwanted gaps are present in the inner casing then air leaks outwards from the inner casing rather than inwards. Thus, any air entering the inner casing is does so via the intended path thereby reducing the possibility of undesirable contamination reaching the electrical apparatus. In particular, if the driven fans are fitted with air filters, then all the air within the inner casing will be filtered air with no possibility of unfiltered air entering through gaps in the inner casing.

As well as protecting the electrical apparatus from condensation, the enclosure should also protect the electrical apparatus from excessive heat. To this end, in preferred embodiments of the invention said outer casing includes a baffle separating a roof chamber bounded by part of said outer casing and said baffle from that part of said outer casing containing said inner casing, said roof chamber having one or more exhaust outlets through said outer casing. Maximum heating from incident sunlight tends to occur on the roof of the enclosure. In

these preferred embodiments the roof area is separated from the electrical apparatus by the baffle as well as the inner casing to thereby provide more effective thermal protection.

This arrangement can also provide a simple way of arranging a partially recirculating airflow. It will be appreciated that whilst in some circumstances full recirculation will be appropriate, a partial recirculation would protect from condensation whilst providing for the removal of some heat from within the enclosure via exhaust air. Partial recirculation can be provided if said one or more outlet openings are disposed adjacent one or more openings in said baffle.

It will be appreciated that the at least partially recirculating airflow can be arranged to pass through an air gap that completely surrounds the inner casing. Whilst such an arrangement would provide good condensation protection, it would give rise to complication in the access to the interior of the inner casing. A preferred compromise arrangement is that a wall of said outer casing and a wall of said inner casing form a double skinned door giving access to said interior of said inner casing. Removal of the double skinned door gives direct access to the interior of the inner casing. The double skinned nature of the door also provides a degree of insulation that will reduce condensation to some extent.

In preferred embodiments of the invention said double skinned door has one or more exhaust outlets and an inner wall with one or more openings into said interior of said inner casing, air within said interior of said inner casing being exhausted via a path through said one or more openings in said inner wall, said double skin door and said one or more exhaust outlets. In this way air from within the inner casing is present on both sides of the inner wall of the double skinned door thereby reducing the likelihood of a temperature difference between the inner wall and the air within the inner casing that could result in condensation.

When condensation has formed on the inner face of the outer casing, it is desirable that it should be removed from the enclosure. To this end, said outer casing has one or more drain holes positioned to allow condensation running down an inner face of said outer casing to drain away. Condensation formed on the inner face of the outer casing is removed via the drain holes to the exterior of the enclosure.

In order to provide more effective condensation protection it is important that the recirculating airflow should pass through substantially all parts of the air gap. It has been found that this desirable result can be achieved by an arrangement in which the spacing between said inner casing and said outer casing on each side face of said enclosure decreases as said side face increases in surface area. The airflow through the air gap of each face is balanced to the other faces by varying the dimension of the air gap.

In order to ensure enhanced protection against contamination the inner casing without undesirably increasing the resistance to the flow of air said one or more outlet openings are covered by bug screens.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a front view of an enclosure with the doors removed; and

Figure 2 shows a cross section along the line A-A of Figure 1 with the doors in place.

Figure 1 shows an electrical apparatus enclosure 2 comprising an outer casing 4 and an inner casing 6. The enclosure 2 is attached to a root section 8 which may be concreted or bolted to the ground. A roof section 10 is disposed on top of the outer casing 4. A roof chamber 12 within the roof section 10 is separated from the inner casing 6 by a baffle 14.

At the base of the inner casing 6 are disposed two driven fans 16. The driven fans 16 draw air from within the air gap between the inner casing 6 and the outer casing 4 and forces this air into the interior of the inner casing 6. The resulting flow of air around the enclosure is illustrated by the various outline arrows in Figure 1 and Figure 2.

The driven fans 16 are variable speed fans with a capacity of 0.37 to 0.74 cubic metres per minute (13 to 26 cubic feet per minute). The capacity of the fans may be increased for a larger volume enclosure or for use in situations where a higher throughput of air is needed for temperature or condensation reduction purposes. The speed of driven fans 16 increases as the temperature of the air passing through the driven fans 16 increases. The driven fans 16 are situated within inlet openings 18 in the inner casing 6.

Air leaves the inner casing 6 through outlet openings 20 at the top of the inner casing 6. Combined bug screens and RFI (radio frequency interference) filters 22 are disposed over the outlet openings 20, no air filter medium being used so as to not undesirably increase the back pressure opposing the flow of air. The action of the driven fans 16 pressurises the air within the inner casing 6 relative to that in the air gap between the inner casing 6 and the outer casing 4. This pressurisation ensures that if there are any leaks in the inner casing, 6 then air will pass outwards rather than inwards.

As can be seen more clearly from Figure 2, some of the air leaving the inner casing 6 through the outlet opening 20 passes up into the roof chamber 12 through an opening 24 in the baffle 14 and some of the air recirculates back down the sides of the inner casing 6 to the driven fans 16. The balance of the recirculating air compared to that which passed into the roof chamber 12 can be adjusted by varying the dimensions of the opening 24 in the baffle 14 and the air gap between the inner casing 6 and the outer casing 4. With an enclosure that is approximately 52 cm deep, 120 cm high and 152 cm wide appropriate dimensions for the side, top and back air gaps have been found to be 5.3 cm, 2.1 cm and 3.0 cm respectively.

A combined finger guard, bug screen, RFI and air filter 26 is disposed over the inlet to each of the driven fans 16. The base of the side walls of the outer casing 4 are provided with drain holes 28 through which condensation formed on the inner face of the outer casing 4 may leave the enclosure.

In Figure 2 the enclosure is shown with a double skinned door 30 in place. The double skinned door 30 provides direct access to the interior of the inner casing 6. An air seal is provided around the periphery of the double skinned door 30. Air is admitted at the base of the double skinned door 30 and exhausted at its top to assist in its properties as a thermal barrier. Small holes 38 (approximately 0.2 cm in diameter) in the inner face of the double skinned door 30 admit the slightly pressurised air from within the inner casing 6 into the space between the two walls of the double skinned door 30. This air serves to reduce the temperature difference between the air within the inner casing 6 and the inner wall of the double skinned door 30. Depending on the amount of convection currently taking place in the air between

the wall of the double skinned door 30, air will either be exhausted from the top or the top and bottom of the door. The size of the holes 38 can be varied to attain the desired degree of their action.

The air that enters the roof chamber 12 leaves through exhaust openings 32. The air that leaves through the exhaust opening 32 serves to remove heat from the interior of the enclosure. At least some new air is allowed to enter the enclosure through the openings 34 towards the bottom of the enclosure. Cable glands 36 in the base of the inner casing 6 allow for the airtight entry and exit of connecting cables to the electrical apparatus within the enclosure.

CLAIMS

1. An electrical apparatus enclosure comprising

an outer casing,

an inner casing with an interior for housing electrical apparatus, said inner casing being disposed within said outer casing and having one or more inlet openings and one or more outlet openings, and

means for causing an at least partially recirculating air flow around a path including said interior of said inner casing and an air gap between said inner casing and said outer casing.

2. An electrical apparatus enclosure as claimed in claim 1, wherein said one or more inlet openings are disposed on a far side of said inner casing relative to said one or more outlet openings.

3. An electrical apparatus enclosure as claimed in any one of claims 1 and 2, wherein said means for causing an at least partially recirculating air flow comprises one or more driven fans.

4. An electrical apparatus enclosure as claimed in claim 3, wherein said one or more driven fans include air filters.

5. An electrical apparatus enclosure as claimed in any one of claims 3 or 4, wherein said one or more driven fans are disposed in said one or more inlet openings and act to increase air pressure within said inner casing above that within said air gap.

6. An electrical apparatus enclosure as claimed in any one of the preceding claims, wherein said outer casing includes a baffle separating a roof chamber bounded by part of said outer casing and said baffle from that part of said outer casing containing said inner casing, said roof chamber having one or more exhaust outlets through said outer casing.

7. An electrical apparatus enclosure as claimed in claim 6, wherein said one or more outlet openings are disposed adjacent one or more

openings in said baffle.

8. An electrical apparatus enclosure as claimed in any one of the preceding claims, wherein a wall of said outer casing and a wall of said inner casing form a double skinned door giving access to said interior of said inner casing.

9. An electrical apparatus enclosure as claimed in claim 8, wherein said double skinned door has one or more exhaust outlets and an inner wall with one or more openings into said interior of said inner casing, air within said interior of said inner casing being exhausted via a path through said one or more openings in said inner wall, said double skin door and said one or more exhaust outlets.

10. An electrical apparatus enclosure as claimed in any one of the preceding claims, wherein said outer casing has one or more drain holes positioned to allow condensation running down an inner face of said outer casing to drain away.

11. An electrical apparatus enclosure as claimed in any one of the preceding claims, wherein the spacing between said inner casing and said outer casing on each side face of said enclosure decreases as said side face increases in surface area.

12. An electrical apparatus enclosure as claimed in any one of the preceding claims, wherein said one or more outlet openings are covered by bug screens.

13. An electrical apparatus enclosure substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9125829.3

Relevant Technical fields

(i) UK Cl (Edition K) H1R (RBL RBM RBK) A4B B8P F4V (VGAC VGAB)

(ii) Int Cl (Edition 5) H05K

Search Examiner

H COLLINGHAM

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

18 MARCH 1992

Documents considered relevant following a search in respect of claims 1-13

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2202681 A (GEC) Whole document	1-5, 12
X	GB 1449895 A (AB SVEADIESEL) Whole document	1-5
X	GB 1084658 A (GRACE) Whole document	1, 10
X	EP 0225954 A1 (ALCAN) Whole document	1-3, 5, 6
X	EP 0112994 A2 (KOO) Whole document	1-3
X	WO 81/01045 A1 (CROMEMCO) Whole document	1, 2
X	US 4495545 A (DUFRESNE) Whole document	1-3, 6-8

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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NAME	COUNTRY
COPPING, STUART FRANK	N/A

ASSIGNEE-INFORMATION:

NAME	COUNTRY
MALCOE PRECISION FABRICATIONS	GB

APPL-NO: GB09125829

APPL-DATE: December 4, 1991

PRIORITY-DATA: GB09125829A (December 4, 1991)

INT-CL (IPC): F24F013/22 , H05K007/20

EUR-CL (EPC): H05K007/20

ABSTRACT:

CHG DATE=19990617 STATUS=O> An electrical apparatus enclosure 2 is provided with an outer casing 4 and an inner casing 6 for housing electrical equipment. Air is recirculated from the

interior of the inner casing 6 through an air gap between the inner casing 6 and the outer casing 4 and back to the interior of the inner casing 6. The recirculation of air reduces the temperature difference between the walls of the inner casing 6 and the air within the inner casing 6. Condensation that forms on the inner face of the outer casing 4 leaves through drain holes 28 at the base of the inner casing 4. A roof chamber 12 is separated from the inner casing 6 by a baffle. Some of the air leaving the inner casing 6 through outlet openings 20 passes into the roof chamber 12 and is exhausted through exhaust openings 32 so as to remove heat from the enclosure. The air may be forced to recirculate by driven fans 16 which are provided with air filters. The pressure of the air within the inner casing 6 is maintained above that of the air in the air gap between the inner casing 6 and the outer casing 4. □